MCB 525, Fall 2016
Project Overview
Sea Anemone Population Genomics

A diverse array of marine invertebrates, including reef-building corals, sea anemones, jellyfish, and sponges, depend on mutualistic relationships with photosynthetic algae of the genus *Symbiodinium*. In these symbioses, algae inside host cells have access to essential nutrients, in return for sugars from algal photosynthesis (Davy et al. 2012). Algal-invertebrate symbioses thus support the tremendous biodiversity of coral reef ecosystems, fisheries and tourism industries, and essential cycling of nutrients in temperate and tropical environments. However, environmental stressors including elevated ocean temperature trigger expulsion of algae from host tissues, or "bleaching", resulting in mortality and reef degradation (Weis 2008). Though vital to informing management efforts, much remains unknown about long-term responses of algal-invertebrate symbioses to an increasingly labile climate.

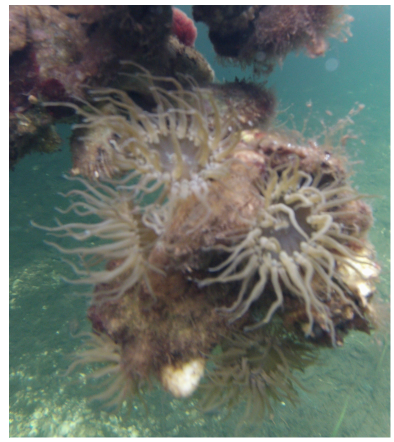
Figure 1. Symbiotic *Aiptasia* sea anemones inhabiting mangrove roots in Bocas del Toro, Panama in August 2013. *Photo: E. Bellis*

Experimentally tractable and easy to maintain, the sea anemone *Aiptasia* has a rich history as a laboratory model for studying coral symbiosis, though little is known about natural populations (Weis et al. 2008). Experiments with laboratory strains have demonstrated that *Aiptasia* naturally associated with one genetically related group of *Symbiodinium,* designated clade A, are more resistant to heat-induced bleaching than strains naturally hosting another group of *Symbiodinium,* designated clade B1 (Bellis & Denver, submitted). Globally, most populations of *Aiptasia* associate with clade B1 *Symbiodinium*, but *Aiptasia* populations in the Western Atlantic form diverse symbioses with *Symbiodinium* of different clades (Thornhill et al. 2013).

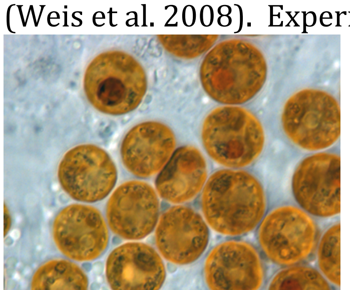
Figure 2. *Symbiodinium* sp. form symbiotic partnerships with corals and sea anemones. *Photo: A. Lewis*

The overarching goal of this project is to investigate symbiosis diversity in Carribbean Aiptasia populations. Our lab has sampled over 200 *Aiptasia* from 4 different sites in Caribbean Panama, where the Smithsonian Tropical Research Institute has collected long-term environmental data for decades (Figure 3). Near the entrance to the Panama Canal, an environment characterized by very warm and variable temperatures, the majority of *Aiptasia* individuals associate with clade A

Symbiodinium, though a handful of individuals were found to associate with *Symbiodinium* clade B1*.* In Bocas del Toro, where average temperatures are cooler and more stable, *Aiptasia* individuals associated primarily with clade B1 *Symbiodinium.*

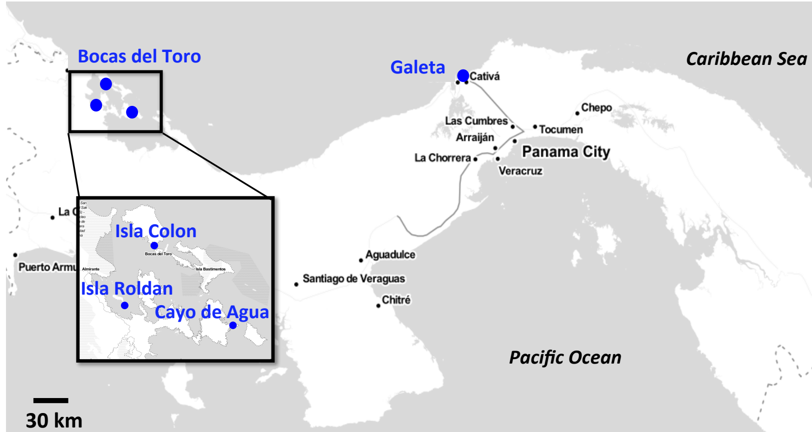

Figure 3. *Aiptasia* sampling locations

Using a cutting-edge genomic approach, our class will perform high-resolution genotyping of host anemones from these populations to evaluate the following hypotheses:

(H_A) Cryptic Population Structure Hypothesis: *Aiptasia* host anemones do not respond to warmer, more variable temperatures by hosting more thermotolerant *Symbiodinium.*
Prediction: Aiptasia hosting clade B1 Symbiodinium in Galeta will be genetically different from other sea anemone hosts in this population.

(H_B) Adaptive Bleaching Hypothesis (Buddemeier and Fautin 1993)**:** *Aiptasia* respond to warmer and more variable temperatures by hosting more thermotolerant *Symbiodinium*.
Prediction: Aiptasia hosting clade B1 Symbiodinium in Galeta will be genetically indistinguishable from other sea anemones in this population.

We will use a 2bRAD genome-wide genotyping approach to address the above hypotheses and to identify particular loci in the host genome that may be important in adaptation to local environmental conditions.

References:
Buddemeier, R. W., and D. G. Fautin. 1993. Coral bleaching as an adaptive mechanism: a testable hypothesis. BioScience 43:320–326.

Davy, S. K., D. Allemand, and V. M. Weis. 2012. Cell biology of cnidarian-dinoflagellate symbiosis. Microbiology and Molecular Biology Reviews 76:229–61.

Thornhill, D. J., Y. Xiang, D. T. Pettay, M. Zhong, and S. R. Santos. 2013. Population genetic data of a model symbiotic cnidarian system reveal remarkable symbiotic specificity and vectored introductions across ocean basins. Molecular Ecology 22:4499–515.

Weis, V. M. 2008. Cellular mechanisms of Cnidarian bleaching: stress causes the collapse of symbiosis. The Journal of Experimental Biology 211:3059–66.

Weis, V. M., S. K. Davy, O. Hoegh-Guldberg, M. Rodriguez-Lanetty, and J. R. Pringle. 2008. Cell biology in model systems as the key to understanding corals. Trends in Ecology & Evolution 23:369–76.